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The Ocean Data Model 302A CSTD oceanographic profiling system is a self-recording, preprogrammable device. The system has been integrated with the Apple Macintosh computer to ield a portable, durable and easy-to-use system for measuring ocean conductivity, temperature, and salinity as a function of depth, and for calculating accurate sound speed values (roughly ± 0.2 m/sec) for acoustic and oceanographic analysis and data quality assurance. This system enables the user to tabulate and plot the above values in near real time for field analysis. Little operator training time is required to operate this system, which has been used successfully in the northeast Pacific and in the Arctic. CSTD data output from the Model 302A reader/recorder are stored on Macintosh 3.5-inch, hard-shelled floppy discs and processed using Microsoft Corporation's program EXCEL. A description of the system, specifications, and user's guide are included, as well as a listing of the routines and samples of the outputs.

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The Ocean Data CSTD Macintosh System

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Foreword

The collection of oceanographic data in support of naval acoustics applications is a cornerstone to development of many new systems and capabilities. The advent of the latest generation of self-recording oceanographic data collection systems based on random access memory has greatly facilitated the acquisition of temperature, salinity, and sound speed data aboard ships of opportunity and in the Arctic environment. This report documents one such system, which, together with a microcomputer and commercially available software, is rugged, portable, and easy to use.

A. C. Esau, Captain, USN
Commanding Officer, NORDA

Executive summary

The Ocean Data Model 302A CSTD oceanographic profiling system is a self-recording, preprogrammable device. The system has been integrated with the Apple Macintosh computer to yield a portable, durable and easy-to-use system for measuring ocean conductivity, temperature, and salinity as a function of depth, and for calculating accurate sound speed values (roughly ±0.2 m/sec) for acoustic and oceanographic analysis and data quality assurance. This system enables the user to tabulate and plot the above values in near real time for field analysis. Little operator training time is required to operate this system, which has been used successfully in the northeast Pacific and in the Arctic. CSTD data output from the Model 302A reader/recorder are stored on Macintosh 3.5-inch, hard-shelled floppy discs and processed using Microsoft Corporation's program EXCEL. A description of the system, specifications, and user's guide are included, as well as a listing of the routines and samples of the outputs.

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Contents

The Ocean Data CSTD Macintosh system

Introduction

The sound speed profile in the water column is critical for acoustic propagation modeling and measurement. The Macintosh-Ocean Data CSTD (MACSTD) system provides a way to measure temperature and salinity, and depth to 1000 m can be converted to sound speed (with an accuracy of 10.2 m/sec), tabulated and plotted for near-real-time quality assurance and use in the field. Tabulations and plots of the sound speed as a function of depth are obtained using the Macintosh personal computer and commercially available software. The Macintosh computer and software is highly interactive; makes extensive use of pull-down menus; and is portable, versatile, and easy to learn and operate. The CSTD sonde and cassette reader/recorder can operate entirely on 12 Vdc battery power, has no electromechanical connections, and is physically very rugged. The graphic output of sound speed versus depth provides oceanographic data quality assurance and a powerful analysis tool for supporting acoustical field experiments. A user's guide appears in Appendix 1.

System hardware description

Figure 1 is a picture of the MACSTD system, which is composed of the Ocean Data Equipment Model 302A CSTD profiling system and an Apple Computer Corporation 512-k Macintosh computer. The system is shown with the probe readied for data transfer to the reader/recorder during recent Arctic experiments. The Model 302A CSTD profiling system consists of three subsystems[1].

- The wet end (sonde), which contains the underwater sensors, electronics, 512-k random-access-memory (RAM) buffer, and battery power source.
- The rechargeable battery-powered reader/recorder, which records data from the sonde buffer, stores it on a special cassette, displays the data on light-emitting diodes (LED), and outputs the oceanographic data via a user-supplied connecting cable to the Macintosh.
- A battery charger for the sonde batteries.

The Macintosh portable field computer consists of the following elements.[2]

- The 512-k RAM, central processing unit (CPU), cathode ray tube (CRT), and keyboard.
- A printer and an external 800-k disc drive.
- Software packages: MS-BASIC[3] and EXCEL[4] by Microsoft Corporation.

Ocean Data Model 302A CSTD oceanographic profiling system

The underwater unit, or sonde, contains the oceanographic sensors. It is 7 inches in diameter, 39 inches long, and weighs 35 pounds. The sensor has such user-selectable features as scanning rate (up to 5 scans/sec), an up-cast disable option, and options on how many parameters are measured. The probe is equipped with a 60-msec-response platinum thermometer, which allows a relatively fast lowering rate without sensor hysteresis. Data logging is initiated when the conductivity measures greater than 2.4 millisiemens (mS) and is terminated when the conductivity falls below 2.4 mS or when the upcast is sensed with the upcast disable circuit enabled. The unit is self-contained, which negates the use of electromechanical connections and, hence, a winch with noisy slip rings. The 13 bits of analog-to-digital resolution are obtained by serial averaging sixteen 12-bit conversions and retaining the 13 most significant bits. The full sensor specifications are given in Appendix 2. The battery-powered reader/recorder transfers the data from the sonde RAM to a special cassette (containing a 1600-FCI clock track) and displays it on the LED display. The reader/recorder is controlled by an 8080 microprocessor and an 8-bit bidirectional data bus. The serial and mode thumb wheels are used to select the various operating modes, including baud rates, internal diagnostics, and RAM testing. A summary of these modes is given in Appendix 3. The microprocessor in the reader/recorder applies previously determined calibration equations to the raw data (conductivity, pressure, and temperature). Salinity and depth are then computed in engineering units for display and/or transfer to the Macintosh. The Microsoft application EXCEL computes the sound speed from the corrected temperature, salinity, and depth measurements. The 512 k of RAM storage in the probe allow for approximately 10,800 scans of conductivity, temperature, and pressure at 5 scans per second. This procedure would require about 600-k of disc space.

Macintosh interfacing and data processing system

The Macintosh connects to the reader/recorder through a standard RS-232 interface with the baud rate selected by the serial and mode thumb wheels on the reader/recorder. Data transfer is initiated by toggling the reset and read switches on the reader/recorder. The Macintosh stores the incoming data for processing and plotting. The data can be stored, processed, plotted, and printed in a matter of minutes. The reader/recorder is connected to the Macintosh by two cables; the first cable is supplied by Ocean Data and connects to the J3 port, and terminates in a DB-25 pin RS-232 connector. The second cable connects this DB-25 pin to the DB-9 pin modem connector in the back of the Macintosh. The pin configurations are given in the table below.

Reader/recorder RS-232 pin connections to Macintosh

Macintosh DB-9	Reader/recorder DB-25	Description
3	7	Ground
6	20	DTS/DTR
9	3	Receive/Send

System processing software

Two Microsoft Corporation software packages are used to obtain and process the calibrated CSTD oceanographic data output from the reader/recorder. MS-BASIC is used for communications with the reader/recorder and EXCEL is used to process the data.

Communications software overview

System disc

The SYSTEM disc must be used in the internal disc drive. This disc contains a folder named SYSTEMS and a file named ATEP. System files, located in the SYSTEM folder, are needed to operate the Macintosh interface and the software used by the **Apple**, **File**, and **Edit** menus. ATEP is an amended version of an example terminal emulation program that was included with the MS-BASIC interpreter to demonstrate advanced programming techniques. ATEP is the MS-BASIC program used for communicating with the CSTD reader-recorder and requires the MS-BASIC interpreter located in the SYSTEMS folder; ATEP recognizes CTD data and inserts the tab characters EXCEL uses to delineate columns of data. The program, ATEP, includes a **Configure** menu, which controls settings like baud rate, number of data bits, and parity. The data can be stored on 3.5-inch, hard-shelled floppy disc as it appears on the CRT by choosing the "Save incoming" option from the **File** menu. The listing for ATEP is given in Appendix 4.

Processing software overview

EXCEL is an integrated software package for Macintosh and is also marketed by the Microsoft Corporation. It includes data base, spread sheet, graphics and macro commands. The macro capability provides for automating the data processing. There are two kinds of EXCEL macros: function and command. Function macros can be used to program function routines much the same way as done in FORTRAN or BASIC. An example is the SSGEN function macro used to calculate sound speed from temperature, depth, and salinity measurements of the CSTD probe. Command macros can be programmed or they can be recorded as a series of keystrokes, mousestrokes, and interactive input. Command macros can be initiated from the "Run..." option in the **Macro** menu or from an assigned command key. The listing of EXCEL macros used to process data are given in Appendix 5 and examples of processed output are given in Appendix 6. Plots and tabulations of temperature, salinity, or sound speed vs. depth and temperature vs. salinity are quickly and easily obtained using EXCEL macros and commands. The EXCEL disc must be used in the external disc drive and contains a folder named MACROS, which is made up of files used by EXCEL to automate the CSTD data processing, tabulation, and plotting. These files are locked and the disc file cannot be changed. However, when these files are open under EXCEL, the working RAM copy of these files can be altered accidentally or purposely. A data file with 700 scans of temperature, salinity, conductivity, depth, and calculated sound speed values uses approximately 35-k of disc space. When more disc space becomes needed, a new 800-k disc should be initialized. All the CTD data files from the EXCEL disc should be transferred to this DATA DISC and deleted from EXCEL.

Summary

The integration of the Macintosh computer and the Ocean Data Equipment 302A CSTD probe yields a powerful system for oceanographic measurements of conductivity, salinty, and temperature as a function of depth and time. Unique features include 12 Vdc operation, compact size, light weight, and ease of use. Commercially available software can be used for data transfer, analysis and sound speed calculation. The user is able to analyze, tabulate and plot results quickly and easily in the field.

References

1. Ocean Data Equipment Division (1985) *CSTD Model 302A Technical Manual*. Middleton, Rhode Island.

2. Apple Computer Corporation (1985). *Macintosh Manual* . Cupertino, California.

3. Microsoft Corporation (1985). *Microsoft BASIC Manual* . Bellevue, Washington.

4. Microsoft Corporation (1985). *EXCEL Manual*. Bellevue, Washington.

Appendix 1: User's guide and operation manual for the MACSTD system

A. Connecting the system

1. Remove the dummy connector from the top of the sonde and connect the sonde-to-reader cable to the sonde and to the port labeled J2 on the reader/recorder unit.

B. Depth profiling data acquisition

1. Rotate power switch on the Reader/Recorder unit to the ON position and toggle the "Sonde Pwr" switch to the ON position.

NOTE: The selectable functions of upcast disable, sample rate selection and the number of parameters per sample are set within the sonde prior to deployment. No action need be taken to actuate these features when taking routine casts.

WARNING: Be sure to reconnect the dummy plug prior to deployment.

2. Lower the probe in the water to desired depth. The lowering rate also is dependent on parameter gradient strength and the desired scanning intensity of the water column.

3. Upon retrieval of the sonde, dry the dummy plug thoroughly, and remove it from the top of the sonde and reconnect the sonde-to-reader connecting cable.

C. Data retrieval

1. Mount the special cassette tape on the capstan drive of the reader/recorder.

2. The tape must be advanced past the transparent leader and to the beginning of tape (BOT) hole. To do this, toggle the "Slew Forward " switch until the tape stops. Toggling this switch twice more will advance the tape to the correct starting position.

3. Select the "Serial no.-Mode no." switches to 05. This activates the circuitry which transfers the contents of the sonde RAM to the reader/recorder cassette.

4. To actuate the transfer of the data in the sonde RAM to the casette tape, toggle the "Stop" and the "Reset" switches in sequence. Next, toggle the "Read" switch. A start-stop motion of the casette tape indicates that data is, in fact, being transferred.

NOTE: If the casette tape does not advance, repeat steps (2) and (3) making sure the BOT hole has advanced past the reading heads.

WARNING: DO NOT TOGGLE THE SONDE PWR SWITCH TO OFF UNTIL THE DATA IS ON THE CASETTE TAPE AND IS VERIFIED.

To do so will erase the contents of the sonde's RAM. "Serial no. - Mode no." switches 02 or 03 can be actuated to be certain that the transfer is complete. The NiCad batteries in the sonde unit and the gel-cell batteries in the reader/recorder should be kept fully charged during the field exercise.

D. Data processing

1. Syntax

Capitalized words refer to copyrighted programs and to discs (Ex: EXCEL). Bold words are titles in the menu bar (Ex: **File**). Words inside quotation marks are commands under the menu bar (Ex: "Save As..."). Underlined words refer to names of EXCEL macro commands and functions (Ex: CSTD.macro).

2. Communications program: ATEP

a. Connect the cable with the RS-232C DB-25 pin connector to the J3 port on the reader/recorder. The RS-232C DB-9 pin end of this cable is connected to the modem connector on the Macintosh.

b. Boot the SYSTEM disc in internal 400k drive and the EXCEL disc in the external 800k drive. Open ATEP on the SYSTEM disc.

c. Choose "Save incoming... " from the **File** menu to save the incoming data on the EXCEL disc. All CSTD casts should have a consecutive number in the file name.

d. Down load the data on the casette to Macintosh by setting the serial-mode thumbwheel switches on the reader/recorder to 57 (transfer at 9600 baud, 7 data bits, 2 stop bits, no parity). Toggle the "Reset" and "Read" switches sequentially on the reader/recorder. The CSTD data will be displayed on the Macintosh screen as the data is transferred.

NOTE: If additional disc space is needed, quit ATEP, initialize a new 800k disc and transfer all of the CTD data files from the EXCEL disc to the new data disc.

e. From the **File** menu choose "Save incoming" again to halt the data saving process and to execute the routine to format the data for EXCEl. For large files this may take a few minutes.

f. Turn off the power to the reader/recorder.

3. Data processing with EXCEL

a. From the ATEP **File** menu choose "Quit" to get back to the desktop and open the EXCEL program.

b. Choose "Open" from the **File** menu to select data for processing. The data can be edited by selecting cells or rows of cells and choosing "Delete" from the **EDIT** menu.

c. Choose "Open" from the **File** menu, select the EXCEL disc and open the CSTD.macro file. DO NOT ALTER THE MACRO FILES!!

d. Make the data worksheet active by choosing it from the **Window** menu or by selecting any cell on the data worksheet.

e. From the **MACRO** menu choose "Run..." and select CSTD.macro!SSGEN to calculate sound speed. This may take minutes for large data files.

f. Choose "Save As..." from the **File** menu to save data on the EXCEL disc or on a data disc.

g. From the **File** menu choose "Open" and select the chart type.

h. Type =Series(, then select the worksheet.

i. Choose "Paste Name" from the **Formula** menu and select the data to be plotted along the horizontal axis.

j. Type a comma, and choose "Paste Name" from the **Formula** menu. Select the data to be plotted along the vertical axis.

k. Type ,1) <comma one close parenthesis> and hit return.

l. To change axis values click on the chart axis and choose "Axis..." from the **Format** menu.

m. To change the title or type, fonts or font size, or to type in other information, hit enter (or choose click on check mark) and place it on the plot in the desired location

n. Plot, print and/or save whatever is desired.

o. Close all files and choose "Quit" from the **File** menu to exit EXCEL.

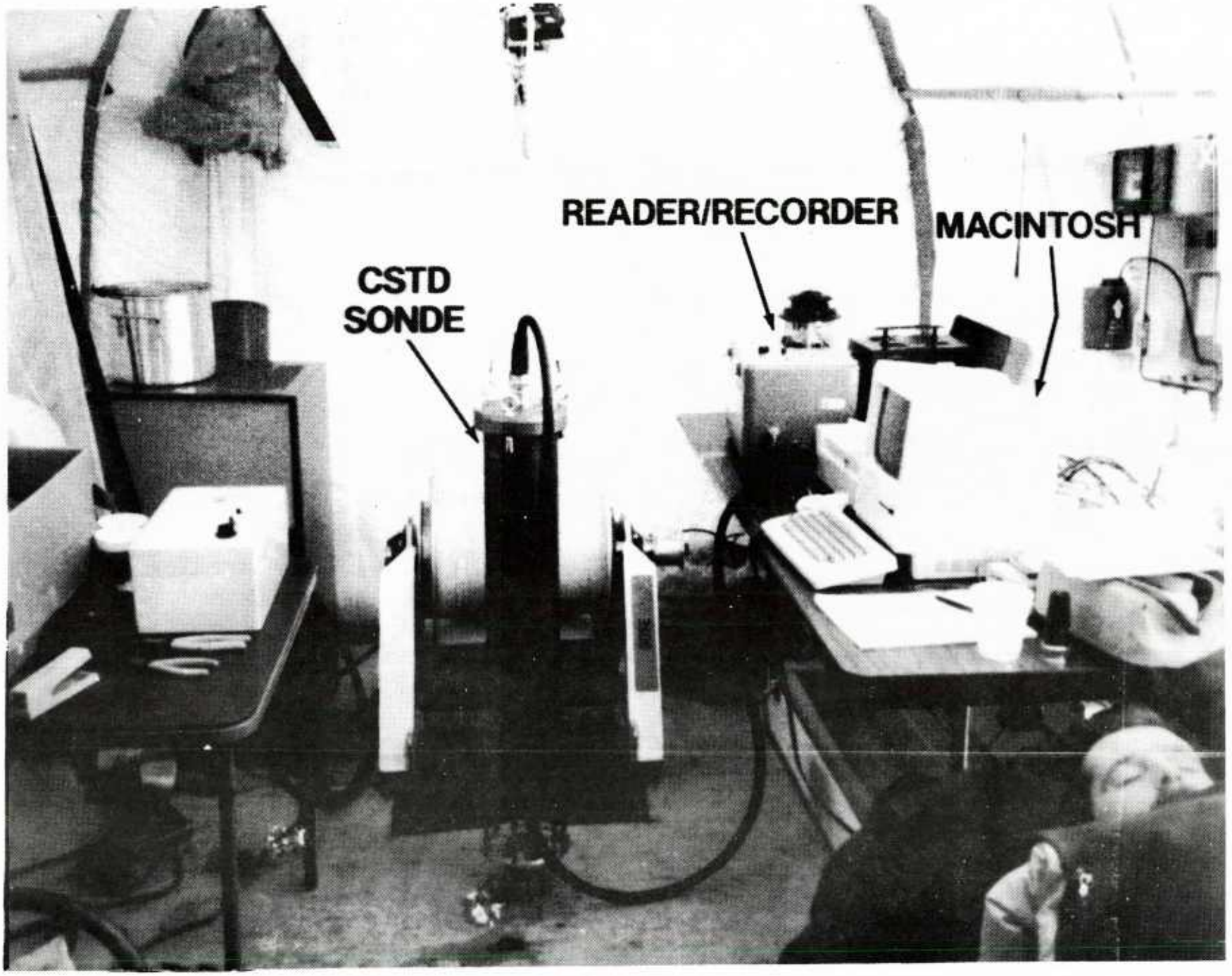

Figure 1. The Macintosh-Ocean Data CSTD system components.

Appendix 2. CSTD sensor specifications

Conductivity:

Measurement Range:	0-65 ms/cm
Accuracy:	± 0.02 ms/cm

Temperature:

Measurement Range:	-2°C to +30°C
Accuracy:	± 0.01°C

Depth :

Measurement Range:	0 to 1000 meters
Accuracy:	± 0.2 meters

Salinity :

Computed using Unesco 1978 equation.

Measurement Range:	0 to 40 ppt
Accuracy:	± 0.03 ppt

Digitizing circuitry :

A/D converter:	Equivalent to 13 bits
Accuracy:	± 1/2 LSB
Sample rate:	100 ms/sample. Selectable in 100 ms steps up to 1 sample per sec through internal jumpers.

Data cable transmission rate: 81k baud serial

Power requirements:

Operating time:	24 hrs continuous before recharge
Battery type:	7 AH rechargeable batteries
Power:	+12Vdc unregulated

Appendix 3. Reader/Recorder operating mode summary

SERIAL MODE		
0	0	Display uncalibrated data automatically.
0	1	Display uncalibrated data manually.
0	2	Display calibrated data automatically.
0	3	Display calibrated data manually.
0	4	Display and record real-time uncalibrated data.
1	4	Display and record real-time calibrated data.
0	5	Transfer sonde RAM to cassette tape.
3	9	Erase cassette tape.
0	6	Output uncalibrated data @ 300 baud.
1	6	Output uncalibrated data @ 600 baud.
2	6	Output uncalibrated data @ 1200 baud.
3	6	Output uncalibrated data @ 2400 baud.
4	6	Output uncalibrated data @ 4800 baud.
5	6	Output uncalibrated data @ 9600 baud.
0	7	Output calibrated data @ 300 baud.
1	7	Output calibrated data @ 600 baud.
2	7	Output calibrated data @ 1200 baud.
3	7	Output calibrated data @ 2400 baud.
4	7	Output calibrated data @ 4800 baud.
5	7	Output calibrated data @ 9600 baud.
0	9	Test RS-232 serial port @ 300 baud.
1	9	Test displays.
2	9	Test RAM.

Appendix 4: ATEP listing for communicating with the CSTD reader/recorder

```
REM Amended Terminal Emulation Program (ATEP)
REM From the example terminal program included with Microsoft BASIC purchase,
DIM nam$(17),GROUP(17),CHOICE%(3,4),mcho$(4)
REM contains terminal parameters baud etc
DIM DT$(2)      :REM used to determine data type cstd or s4
DIM H$(6,2)     :REM will contain S4 header information

GOSUB INIT
'Display characters from COM1, send keystrokes to COM1
loop:
 IF DT% =1 THEN csin
 in$= INPUT$(LOC(1),1): PRINT in$;
 IF LOC(1) =0 THEN keyin
 IF stfl%=2 THEN PRINT#3, in$;
 GOTO loop
csin:
 IF LOC(1)<=8 THEN keyin
 LINE INPUT #1,in$:PRINT in$
 IF stfl%=2 THEN PRINT#3,in$
 GOTO loop
keyin:
 k$=INKEY$
 IF k$="" THEN loop
 PRINT #1,k$;: PRINT k$;
 IF stfl%=2 THEN PRINT#3, k$;
 GOTO loop
CSTDT:
REM --- Purpose is to replace spaces in cstd files with tabs
WHILE NOT EOF(3)
 LINE INPUT #3,R$
 RL%=LEN(R$)
 IF RL%< 10 THEN nil  :REM skip Blnk Lines
 S=VAL(MID$(R$,50,4)) :REM used TO Check FOR RUN Numbers
 IF ASC(MID$(R$,9,1)) <= 57 THEN infor  :REM found profile numbers
 ICRU=S                :REM found current run number
 IF ICRU <= IOLR THEN nil        :REM current run= old run so skip
 PRINT #5,H1$;ICRU;HO$;H2$;H3$:IOLR=ICRU  REM new RUN Number So PRINT Header
 GOTO nil     :REM get next line
```

```
infor:
 MID$(R$,8,1)=TA$
 MID$(R$,14,1)=TA$
 MID$(R$,22,1)=TA$
 MID$(R$,30,1)=TA$
 PRINT #5, R$
nil:
WEND
S4CON:
REM  Purpose to decode and convert to usful units output from S4 meter
HYN=0  :REM NO HEADER READ YET
WHILE NOT EOF (3)
 LINE INPUT #3,R$
 RL%=LEN(R$)  :REM length Of RECORD
 IF RL% <20 THEN fin       :REM blank LINE OR SPECIAL RECORD BLOCK
 IF LEFT$(R$,1)="}" OR LEFT$(R$,2)="RD" THEN GOSUB COMM
 IF HYN=0 THEN GOSUB HEAD:      REM header Of Some Kind
  FOR IC% = 1 TO RL% STEP 12   :REM ic Is Charcter Position In RECORD
REM divy up data from record file
    A$="&H"+MID$(R$,IC%,3)  :N=VAL(A$)
    A$="&H"+MID$(R$,IC%+3,3) :E=VAL(A$)
    A$="&H"+MID$(R$,IC%+7,4) :P=VAL(A$)
REM convert to engineering units
    IF N>C1 THEN N=N-C2
    IF E> C1 THEN E=E-C2
    N=N/5:E=E/5
    S=SQR(N*N + E*E)
    D=C4*P
    IF N=0 THEN V=90*SGN(E) ELSE V=ATN(E/N)*C6#
    IF N<0 THEN V=V+180 ELSE IF E<0 THEN V=V+360
    REM  PRINT  D;TA$;S;TA$;V
    PRINT #5, D;TA$;S;TA$;V
  NEXT IC%
fin:
WEND
RETURN
sainc:
REM stfl%   'if =2 then save incoming is on ( if =1 save incoming is off)
 DT$(1)=".CTD"  :REM extension FOR Each Type Of DATA file
 DT$(2)=".S4"
 IF DT%=0 THEN GOSUB GEDATY
 ON stfl% GOSUB coff,con
 MENU 1,1,stfl%
RETURN
coff:
REM turn Check Mark ON & Save DATA
 stfl%=2
 N$ = FILES$ (0,"Please input a name for this data file.")
 IF N$="" THEN stfl%=1: RETURN
 OPEN N$ FOR OUTPUT AS 3   :REM OPEN FOR OUTPUT UNIT 3 AS N$
RETURN
```

```
con:  REM turn Check Mark OFF AND Convert DATA
 stfl%=1
 CLOSE #3
 cn$=N$+DT$(DT%)
OPEN cn$ FOR OUTPUT AS 5
OPEN N$ FOR INPUT AS 3
 IF DT%=1 THEN GOSUB CSTDT
 IF DT%=2 THEN GOSUB S4CON
CLOSE 3
CLOSE 5
KILL N$
RETURN
GEDATY:
WINDOW 2,"PLEASE SELECT INCOMING DATA TYPE",(50,100)-(350,225),1
BUTTON 1,1,"CSTD data",(100,20)-(200,50),1
BUTTON 2,1,"S4 data",(100,70)-(200,100),1
WHILE DIALOG(0)<>1:WEND
IF DIALOG(0)=4 THEN RETURN: REM WINDOW CLOSED BY USER W/O BUTON
 BP=DIALOG(1)  :REM number Of BUTTON Pushed
 IF BP=1 THEN DT%=1:MENU 3,1,2:MENU 3,2,1
 IF BP=2 THEN DT%=2:MENU 3,2,2:MENU 3,1,1
WINDOW CLOSE 2
CLOSE 1
GOSUB OPORT
RETURN
senfi:
 NF$=FILES$(1,"TEXT")
 IF NF$="" THEN RETURN
OPEN "I",5,NF$
 WHILE NOT EOF(5)
  INPUT #5, cn$
  PRINT #1, cn$
  FOR i=1 TO 200 :NEXT
 WEND
CLOSE 5
RETURN
OPORT:
REM MAPBUTTON CHOICES TO OPEN PORT STATMENT
 mcho$(1)=  LEFT$(nam$(CHOICE%(DT%,1)),4)
 mcho$(2)=","+LEFT$(nam$(CHOICE%(DT%,2)),1)
 mcho$(3)=","+LEFT$(nam$(CHOICE%(DT%,3)),1)
 mcho$(4)=","+LEFT$(nam$(CHOICE%(DT%,4)),1)
REM PRINT "OPORT ";mcho$(1);mcho$(2);mcho$(3);mcho$(4)
REM --- Open Communications port with 30000 byte input buffer
OPEN "COM1:"+mcho$(1)+mcho$(2)+mcho$(3)+mcho$(4) AS 1 LEN=15000
RETURN
INIT:
 TEXTFONT 4
 TEXTSIZE 9
 TEXTMODE 1
stfl%=1    :REM save Incoming Is OFF ( =2 Save Incoming Is ON)
```

```
DT%=0      :REM data Type Undetermined.
REM constants used for cstd headers
CR$=CHR$(13)+CHR$(10)
TA$=CHR$(9)     :REM tab Character
H1$="OCEAN DATA"+TA$+"CSTD MODEL 302"+TA$+"RUN"+TA$
HO$=CR$+CR$+CR$
H2$="ID #"+TA$+"COND"+TA$+"TEMP"+TA$+"DEPTH"+TA$+"SALIN"+CR$
H3$=TA$+"MS/CM"+TA$+"DEG C"+TA$+"METER"+TA$+"PPT"+CR$
IOLR=0
REM used in S4 routine to convert to engineering units
 C1=2047     :REM engineering Conversion Constants
 C2=4096
 C4=1000/1023   :REM 70/16383=70M 1000/1023=1000M TRANSDUCERS
 C6#= 180/3.141592654#    :REM rad->Deg CoNversioN Double Precision
REM --- Setup menu
MENU 1,0,1,"File"
MENU 1,1,stfl%,"Save incoming"
MENU 1,2,1,"Send file"
MENU 1,3,0," ----------"
MENU 1,4,1,"Quit"
MENU 2,0,1,"Configure"
MENU 2,1,1,"Clear Screen"
MENU 2,2,1,"Set parameters"
MENU 3,0,1,"Data Types"
MENU 3,1,1," CSTD data"
MENU 3,2,1," S4 data"
MENU 4,0,1,""
MENU 5,0,0,""
ON MENU GOSUB HANDMEN
MENU ON
REM --- Setup default options
CHOICE%(0,1)=7 :nam$(7)="9600"  :REM 9600 Baud
CHOICE%(0,2)=8 :nam$(8)="N" :REM no Parity
CHOICE%(0,3)=14 :nam$(14)="8" :REM 8 DATA bits
CHOICE%(0,4)=16 :nam$(16)="2" :REM 2 STOP Bit
     VAX, DT%=0 :REM DEFAULT TO 240 Vax
CHOICE%(1,1)=7  :REM 9600 Baud
CHOICE%(1,2)=8  :REM no Parity
CHOICE%(1,3)=13 :nam$(13)="7" :REM 7 DATA bits
CHOICE%(1,4)=16 :REM 2 STOP Bit     :REM DEFAULT TO CSTD, DT%=1
CHOICE%(2,1)=7  :REM 9600 Baud
CHOICE%(2,2)=9 :nam$(9)="O" :REM ODD parity
CHOICE%(2,3)=13 :REM 7 DATA bits
CHOICE%(2,4)=15 :nam$(15)="1" :REM 1 STOP Bit   :REM DEFAULT TO S4 DT%=2
GOSUB OPORT
RETURN
HANDMEN:
 'MENU 4,1,1,"heap "+STR$(FRE(-1))
 'MENU 4,2,1,"stack "+STR$(FRE(-2))
 'MENU 4,3,1,"data "+STR$(FRE(0))
 MENO = MENU(0):  ME1 = MENU(1)
```

```
ON MENO GOSUB fi,co,dc
MENU: RETURN
fi:
 IF ME1 = 4 THEN END
 IF ME1 =2 THEN GOSUB senfi
 IF ME1 =1 THEN GOSUB sainc
RETURN
co:
 ON ME1 GOSUB co1,co2
RETURN
co2:
 CLOSE 1 :REM else It Must Be Set Configuration Parameters
 WINDOW 2,,(50,50)-(450,250),2
 GOSUB DISPLAYDEFAULTS
 GOSUB SELECTOPTIONS
 GOSUB OPORT
 WINDOW CLOSE 2
co1:
 CLS: RETURN
dc:
REM data conversion routines
 IF ME1 =1 THEN DT%=1:MENU 3,1,2:MENU 3,2,1
 IF ME1 =2 THEN DT%=2:MENU 3,2,2:MENU 3,1,1
 CLOSE 1
 GOSUB OPORT :REM OPEN PORT WITH DT% VALUES FOR MODEM PORT
RETURN
DISPLAYDEFAULTS:
REM *** Prompt user for Communications Parameters
 RESTORE
 FOR i=1 TO 16
  READ X,Y,GROUP(i),nam$(i)
  BUTTON i,1,nam$(i),(X,Y)-(X+135,Y+15),3
 NEXT i
 BUTTON 17,1,"Ok",(310,110)-(350,150)
REM *** Simulate button pushes to highlight defaults
 FOR i=1 TO 4
  BUTUNID=CHOICE%(DT%,i) :GOSUB SELECTBUTUN
 NEXT i
RETURN
REM --- x,y coordinate of button, groupid, title
DATA 10,10,1,"110 bits per sec"
DATA 10,30,1,"300 bits per sec"
DATA 10,50,1,"600 bits per sec"
DATA 10,70,1,"1200 bits per sec"
DATA 10,90,1,"2400 bits per sec"
DATA 10,110,1,"4800 bits per sec"
DATA 10,130,1,"9600 bits per sec"
DATA 290,10,2,"No parity"
DATA 290,50,2,"Odd parity"
DATA 290,30,2,"Even parity"
DATA 150,10,3,"5 Data bits"
```

```
DATA 150,30,3,"6 Data bits"
DATA 150,50,3,"7 Data bits"
DATA 150,70,3,"8 Data bits"
DATA 150,110,4,"1 Stop bits"
DATA 150,130,4,"2 Stop bits"
SELECTOPTIONS:
SELECTLOOP:
 D=DIALOG(0)
 IF D<>1 THEN SELECTLOOP
 BUTUNID=DIALOG(1)
 IF BUTUNID<17 THEN GOSUB SELECTBUTUN: GOTO SELECTLOOP
RETURN
REM --- The user has just pushed a button. Highlight
REM --- that button and remember the selection in CHOICE%
SELECTBUTUN:
 GROUPID = GROUP(BUTUNID)
 IF CHOICE%(DT%,GROUPID)>0 THEN BUTTON CHOICE%(DT%,GROUPID),1
 BUTTON BUTUNID,2
 CHOICE%(DT%,GROUPID) = BUTUNID
RETURN
HEAD:
REM -------USED BY S4 ROUTINE TO DESCRAMBLE & PRINT S4 HEADER ---------
REM process header
HYN=1  :REM turn header flag on
H$(1,1)="Serial number: " :
H$(1,2)=MID$(R$,1,2)+MID$(R$,4,2)+MID$(R$,7,2)+MID$(R$,10,2)
H$(2,1)="Data header: ":H$(2,2)=MID$(R$,13,15)
H$(3,1)="Vector average interval (secs): "
H$(3,2)=STR$(VAL("&H"+MID$(R$,47,2)+MID$(R$,50,2))/2)
H$(4,1)= "Date of data block:"
H$(4,2)=MID$(R$,122,2)+"/"+MID$(R$,125,2)+"/"+MID$(R$,128,2)
H$(5,1)="Time of data block: ":H$(5,2)=MID$(R$,131,2)+":"+MID$(R$,134,2)
REM---------- print to screen -----------
 FOR i=1 TO 5
  PRINT H$(i,1);TA$;H$(i,2)
 NEXT i
REM ---------- PRINT TO OUTPUT file --------
 FOR i=1 TO 5
  PRINT #5, H$(i,1);TA$;H$(i,2)
 NEXT i
 PRINT #5, "Depth (m)";TA$;"Spd (cm/s)";TA$;"Dir (deg)"
RETURN
COMM:
REM --------USED BY S4 ROUTINE: ASSURES AN RD1 COMMAND WAS USED TO
RETRIEVE
REM DATA ALSO WILL BE USED IN FUTURE VERSIONS TO EXPAND COMMAND
HANDLING
 RD=1   :REM assume Rd1 Command Was Used
 A$=" Well Excuse me, this is not a supported command."
 B$="Please use the RD1 command to retrieve S4 data"
 H1$=" OR reinitialize the S4 and repeat the profile."
```

```
IF (LEFT$(C$,4) <> "}RD1" AND LEFT$(C$,3)<>"RD1") THEN RD=0
REM false, NOT An RD1 Command
IF (LEFT$(C$,2) <> "}G" AND LEFT$(C$,1)<>"G") THEN GC=0
REM false, NOT A Group Command
IF (RD=0 AND GC=0 )THEN
PRINT A$:PRINT C$:PRINT B$:PRINT H1$:PRINT
INPUT "Continue anyway ? (Y/N)";A$
END IF
A$=A$+"N": B$=LEFT$(A$,1)
IF B$="n" OR B$="N" THEN END
RETURN
```

Appendix 5: EXCEL macro listing for processing the CSTD data

```
SoundSpeed
 =RESULT(1)
 =ARGUMENT("t",1)
 =ARGUMENT("z",1)
 =ARGUMENT("s",1)
A6=z/10
A7=1402.392+5.01109398873*t-0.0550946843172*t^2+0.00022153596924*t^3
A8=A7+1.32952290781*s+0.000128955756844*s^2
A9=A8-0.0127562783426*t*s+0.000096840315641*t^2*s
 =IF(A6=0,RETURN(A9))
A11=A9+0.156059257041*A6+0.0000244998688441*A6^2-8.83392332513E-09*A6^3
A12=A11+0.00635191613389*t*A6+0.000000026548471660 8*t^2*A6^2-
0.00000159349479045*t*A6^2
A13=A12+5.22116437235E-10*t*A6^3-0.000000438031096213*t^3*A6-1.61674495909E-
09*s^2*A6^2
A14=A13+0.00000485639620015*t*A6*s^2-0.000340597039004*t*s*A6
 =RETURN(A14)

A17=headers()
reduces data by skipping in increments input by user
 =SELECT(OFFSET(sd,0,2):OFFSET(en,0,3),OFFSET(sd,0,2))
 =CLEAR(1)
 =SELECT(OFFSET(sd,-3,2),OFFSET(sd,-3,2))
 =FORMULA("Sound Speed")
 =ALIGNMENT(3)
 =SELECT(OFFSET(sd,-2,2),OFFSET(sd,-2,2))
 =FORMULA("meters/sec")
 =ALIGNMENT(3)
 =SELECT(OFFSET(sd,-3,3),OFFSET(sd,-3,3))
 =FORMULA("Avg. Depth")
 =ALIGNMENT(3)
 =SELECT(OFFSET(sd,-2,3),OFFSET(sd,-2,3))
 =FORMULA("meters")
 =ALIGNMENT(3)
 =GOTO(A38)
Decimator
 =GOTO(A17)
A38=SET.NAME("na",INPUT("Please enter the number of points to skip.",1,"INPUT SKIP
INTERVAL")-1)
 =IF(na<0,RETURN())
```

```
 =SELECT(OFFSET(sd,-4,2),OFFSET(sd,-4,2))
 =FORMULA("Keeping every ")
 =ALIGNMENT(3)
 =SELECT(,"rc[1]")
 =FORMULA(na+1&" th value")
 =ALIGNMENT(3)
 =SET.NAME("npt",COUNT(!F:F))
 =SET.NAME("ac",2)
 =SET.NAME("arco",1)
A49=SET.NAME("arro",0)
 =SET.NAME("ba",0)
A51=SELECT(OFFSET(sd,arro,ac),OFFSET(sd,arro,ac))
 =FORMULA(OFFSET(sd,ba,arco))
 =SET.NAME("ba",ba+na+1)
 =SET.NAME("arro",arro+1)
 =IF(ba<npt,GOTO(A51))

do it again for depth data
 =IF(arco=-1,GOTO(A66))
 =SET.NAME("ac",3)
 =SET.NAME("arco",-1)
 =GOTO(A49)
A66=MESSAGE(FALSE)
 =SELECT(OFFSET(sd,0,2),OFFSET(sd,0,2))
 =HALT()

finddata
 =SET.NAME("dst",!E5)
 =SET.NAME("rof",0)
 =SET.NAME("cof",0)
C5 =SELECT(OFFSET(dst,rof,cof),OFFSET(dst,rof,cof))
 =IF(AND(DEREF(ACTIVE.CELL())>0,TYPE(ACTIVE.CELL()) =1),GOTO(C9))
 =SET.NAME("rof",rof+1)
 =GOTO(C5)
C9 =SET.NAME("sd",OFFSET(dst,rof,cof))
 =SELECT(sd,sd)
 =SET.NAME("np",COUNT(!E:E))
 =SET.NAME("en",OFFSET(sd,np-1,0))
 =DEFINE.NAME("Salinity",sd:en)
 =DEFINE.NAME("Depth",OFFSET(sd,0,-1):OFFSET(en,0,-1))
 =DEFINE.NAME("Temp",OFFSET(sd,0,-2):OFFSET(en,0,-2))
 =DEFINE.NAME("Sound_Speed",OFFSET(sd,0,1):OFFSET(en,0,1))
 =RETURN()
Sound Spd Generator
SSGEN
 =finddata()
 =MESSAGE(TRUE,"Calculating Sound Speeds... please wait.")
 =SELECT(OFFSET(sd,-3,1),OFFSET(sd,-3,1))
 =FORMULA("SND SPD")
 =SELECT(,"R[1]C")
```

```
 =FORMULA("M/SEC")
 =SELECT(OFFSET(sd,0,1),OFFSET(sd,0,1))
 =FORMULA("=ctd2.macro!SoundSpeed(rc[-3],rc[-2],rc[-1])")
 =SELECT(ACTIVE.CELL():OFFSET(en,0,1),ACTIVE.CELL())
 =FILL.DOWN()
 =SELECT(OFFSET(sd,0,1):OFFSET(en,0,1),OFFSET(sd,0,1))
 =COPY()
 =PASTE.SPECIAL(3,1)
 =FORMAT.NUMBER("0.00")
 =CANCEL.COPY()
 =SELECT(OFFSET(sd,0,1),OFFSET(sd,0,1))
 =MESSAGE(FALSE," ")
 =DEFINE.NAME("Sound_Speed",OFFSET(sd,0,1):OFFSET(en,0,1))
 =HALT()

plot_ssvsd
  =SET.NAME("np",COUNT(!H:H))
  =SET.NAME("en",OFFSET(sd,np-1,1))
  =SELECT(OFFSET(sd,0,2):OFFSET(en,0,2))
  =COPY()
  =OPEN("Deci.SS CHART",FALSE)
  =PASTE.SPECIAL(2,FALSE,TRUE)
  =RETURN()
```

Appendix 6: Examples of MACSTD output

The MACSTD system was field tested in the Chukchi Sea during the spring of 1986. Figure A.1 is an example of a sound speed profile measured during the field test. This data was collected with the upcast disabled. The preset probe scan rate was one scan every 6.4 seconds with a data decimation rate of every third tabulated data point.

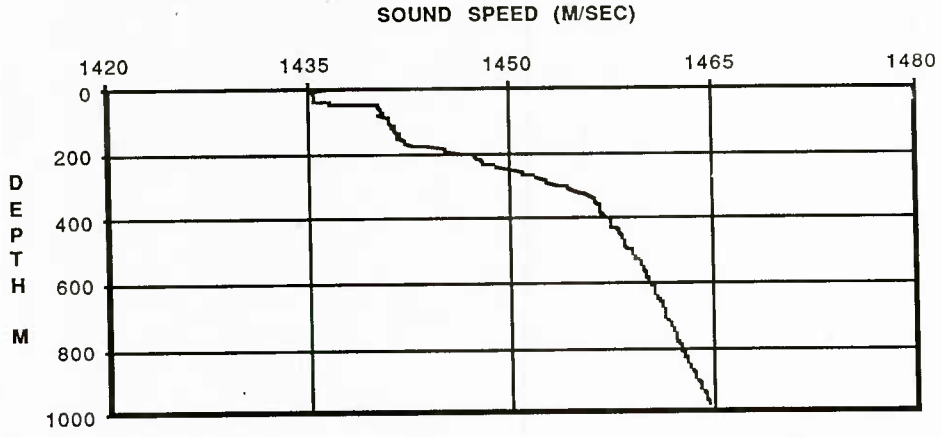

Figure A.1: Example of EXCEL graphic output of sound speed vs. depth from data taken in the Chukchi Sea.

The EXCEL program allows many options in plotting the data through the use of pull-down menus. Axes scaling and plotting are easily changed, text is easily added and can be formatted by size, font type, and style (bold, italic, outline etc.). The type of plot is also easily changed, line, bar, or scatter and combinations are possible. Also, patterns and shapes for the data, axes, borders etc each have options. These formatting parameters can be set as the default plot. EXCEL can show 102 points as a single data series in a plot but there is no limit to the number of these series that can be shown on one plot.

A portion of the undecimated EXCEL data tabulation for this CTD output from the reader/recorder and the corresponding calculated sound speed from the EXCEL macro is shown on table A.1.

Raw data tabulation from the reader/recorder to EXCEL.

OCEAN DATA		CSTD MODEL		RUN 1
ID #	COND MS/CM	TEMP DEG C	DEPTH METER	SALIN PPT
0	24.4	-1.6	.1	30.5
1	24.8	-1.5	.9	31.0
2	24.7	-1.6	3.2	30.8
3	24.2	-1.6	8.4	30.3
4	24.2	-1.6	15.5	30.2
5	24.2	-1.6	21.3	30.3
6	24.2	-1.7	25.5	30.2
7	24.2	-1.7	29.3	30.3
8	24.2	-1.7	33.5	30.2
9	24.2	-1.7	35.8	30.3
10	24.2	-1.7	38.3	30.3
11	24.2	-1.6	39.7	30.2
12	24.2	-1.6	40.0	30.3
13	24.7	-1.6	43.0	30.8